

# Diffusing the situation

Probing water sorption  
in switchable membranes  
& polymers

**Water sorption and diffusion  
in materials are critical  
for many applications.**

Hidden Isochema instruments determine both water sorption equilibria and kinetics to high precision, providing essential information for any application in which moisture plays a key role. In this issue, we look at recent studies on membranes and polymers using our IGA and IGAsorp high accuracy vapor sorption analyzers.





# Diffusing the situation, Probing water sorption in switchable membranes & polymers

In a study led by a team from the National Graphene Institute in Manchester, a series of laminate membranes were fabricated from the 2D transition metal dichalcogenide, MoS<sub>2</sub>.<sup>[1]</sup> The membranes mostly consist of the metastable 1T' phase, but this can be converted to a more stable hexagonal 2H phase by annealing. The proportion of 2H was found to have a profound effect on the water permeation rate.

Crucially, however, the team found that soaking the 1T' membranes in either acidic or basic solutions also had a dramatic effect on water permeation, depending on the pH of the solution. In addition, the membranes exhibited hysteretic behavior. While increasing the pH of the soaking solution from 1.0 to 12.1, the membrane was impermeable, but it became permeable at a pH of around 11. While decreasing the pH from 12.1 to 1.0, however, the membrane remained permeable until a pH of about 4.

Water vapor sorption isotherms were measured using an IGA on MoS<sub>2</sub> membranes exposed to different pHs. The isotherms showed significant differences, closely mimicking the hysteretic response in water permeability. This provided vital supporting data for the study of these switchable membranes, which have potential applications in autonomous wound infection monitoring and pH-dependent nanofiltration. The paper was co-authored by scientists from the University of Cambridge, Xiamen University, Dalian University of Technology, University of York, and National University of Singapore, and was published in Nature earlier this year.<sup>[1]</sup>

A French team, meanwhile, recently studied the effect of soaking sulfonated poly(ether ether ketone) (sPEEK) membranes in an acid solution, to improve their performance in proton exchange membrane (PEM) fuel cells.<sup>[2]</sup> Various pretreatments were tested and the best performance was found for a protocol including acidification, hydro-alcoholic and hydrothermal steps. An IGAsorp was used to measure water sorption isotherms on each of the membranes studied.

A further example was provided recently by researchers at Lawrence Livermore National Laboratory (LLNL) in the US. Water vapor sorption isotherms were determined using an IGAsorp on four materials, including two filled polydimethylsiloxane (PDMS) samples and a polymer composite.<sup>[3]</sup> Different isotherm types were exhibited by the four materials and the experimental data were successfully described using a new sorption and diffusion model, which includes Henry's law, Langmuir and 'pooling' modes. The model should prove useful for describing water sorption and diffusion in various types of materials for a wide range of applications.



## References

- [1] C. Y. Hu, A. Achari, P. Rowe, H. Xiao, S. Suran, Z. Li, K. Huang, C. Chi, C. T. Cherian, V. Sreepal, P. D. Bentley, A. Pratt, N. Zhang, K. S. Novoselov, A. Michaelides & R. R. Nair, *Nature*, 2023, 616, 719-723
- [2] M. Daoudi, E. Ferri, C. Tougne, A. El Kaddouri, J.-C. Perrin, J. Dillet, L. Gonon, V. Mareau, H. Mendil-Jakani, V. Dufaud, E. Espuche & O. Lottin, *Journal of Polymer Science*, 2023, 61, 761-776
- [3] S. T. Castonguay, P. Roy, Y. Sun, S. Aubry, B. Foley, E. A. Glascoe & H. N. Sharma, *Chemical Engineering Science*, 2023, 275, 118695



# IEA Hydrogen Task 40 meeting comes to the UK!



In May this year, the University of Nottingham in the UK hosted the latest meeting of the IEA Hydrogen TCP Task 40 on Energy Storage and Conversion Using Hydrogen.

33 experts from 14 countries travelled to Nottingham to present their latest research results. Talks on various critical aspects of research and development into hydrogen storage and conversion methods were presented, including hydrogen storage in porous materials, hydrides for thermal energy storage, new borohydrides for hydrogen storage and solid state battery technology, and liquid organic hydrogen carriers.

Hidden Isochema was delighted to sponsor the event, which included a trip to the Blue John Cavern in the Peak District.



## Launch of the EPSRC Network on Engineering Porous Materials at Multiple Scales (EPoMM)

EPoMM aims to foster multiscale and applications-led collaboration of scientists and engineers working on porous materials across a range of research areas.

Partners in the network include various UK universities, alongside Hidden Isochema and other companies, such as Johnson Matthey and Porotech, a University of Cambridge spin-out. The first steering group meeting was held in late September. EPoMM is led by Professor Chris Bowen and Dr Alex O'Malley from the University of Bath, UK. To join and receive details of newsletters, workshops, and other EPoMM activities, please email the network at [EPoMM@bath.ac.uk](mailto:EPoMM@bath.ac.uk)

# New journal Green Carbon

Green Carbon, published by Elsevier and sponsored by the Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences (QIBEBT, CAS), is a new journal focused on minimizing CO<sub>2</sub> emissions for a sustainable future and a greener society.

The first Editorial Board Meeting was held in Qingdao in July and was attended by Dr Darren Broom. The journal covers the utilization of green carbon resources, the development of green conversion technologies, the management of the carbon life cycle, and the revolution of the carbon research paradigm. Green Carbon is open access, with article processing charges waived for any manuscript submitted before 31st December 2025.

For further information, please visit the journal website:  
<https://www.keaipublishing.com/en/journals/green-carbon/>



# Challenges in characterizing adsorbents for gas storage and separation

A new article by Hiden Isochema product manager Dr Darren Broom examines the practical challenges in characterizing adsorbents for gas adsorption applications.

Published in a Special Issue of the journal Adsorption in honor of Dr Orhan Talu, the article covers challenges for high pressure gas adsorption, multicomponent gas adsorption equilibria, and measuring gas adsorption kinetics and diffusion. Different definitions of adsorption, including net, excess and absolute, are also discussed.

Recent advances such as the production of high pressure CO<sub>2</sub> and CH<sub>4</sub> adsorption data on NIST reference materials are covered, but the core of the article is a detailed discussion of why binary and multicomponent gas adsorption measurements are so difficult. Typical multicomponent techniques require large samples and are time-consuming, and this has led to a lack of multicomponent data in the literature. The recent introduction of the **Integral Mass Balance (IMB)** method by Hiden Isochema is a significant advance in this respect.

The article also includes an introduction to the data required to assess materials for gas storage and separation applications, and should serve as a useful introduction to newcomers to the field.



Challenges in characterizing adsorbents for gas storage and separation  
**D. P. Broom, Adsorption, 2023,**  
DOI: [10.1007/s10450-023-00424-9](https://doi.org/10.1007/s10450-023-00424-9)

## PUBLICATION ROUND-UP

### Water harvesting

#### Harvesting of aerial humidity with natural hygroscopic salt excretions

M. B. Al-Handawi, P. Commins, R. E. Dinneber, M. Abdellatif, L. Li and P. Naumov

Proceedings of the National Academies of Sciences of the USA, 2023, 120, e2313134120

A study led by a team from Abu Dhabi in the United Arab Emirates explored the physicochemical aspects of salt release and water collection mechanisms of a desert shrub, Athel tamarisk, which survives in arid, hypersaline conditions. An IGAsorp was used to measure water sorption isotherms at 25°C on a clean branch and a branch with salt crystals attached to its surface, and dramatic differences were observed. An eightfold increase in water collection capacity was determined, compared to the clean branch. The results from the various techniques used in the study open prospects for a bioinspired approach to efficient harvesting of aerial water.

### Carbons

#### Reference isotherms for water vapor sorption on nanoporous carbon: results of an interlaboratory study

H. G. T. Nguyen, B. Toman, R. D. van Zee, et al

Adsorption, 2023, 29, 113-124

An interlaboratory study, sponsored by the Versailles Project on Advanced Materials and Standards (VAMAS) and led by the US National Institute of Standards and Technology (NIST), examined water sorption isotherms at 25°C on BAM-P109, a pelletized nanoporous carbon reference material. Thirteen laboratories participated, including Hiden Isochema, contributing nine pure water vapor sorption isotherms and four relative humidity isotherms. Reference isotherms, with a 95% uncertainty interval, were produced, providing vital data for researchers wishing to validate their water sorption instruments and measurement protocols.

## Discovering more. Seeing more.

DATE	CONFERENCE	LOCATION
15-16 January	RSC CNN (RSC Chemical Nanoscience and Nanotechnology Network Annual Symposium)	London, UK
7-8 February	AFA (French Adsorption Association)	Caen, France
17-18 February	2nd International Conference on Novel Materials and Technologies for Energy and Environment	Hyderabad, India
26-31 May	MH2024 (18th International symposium on metal-hydrogen systems)	St Malo, France
4-5 June	UKPorMat (UK Porous Materials Conference)	Liverpool, UK
2-5 July	BZA (British Zeolite Association Meeting)	Ambleside, UK
15-19 July	MOF2024 (9th International Conference on Metal-Organic Frameworks & Open Framework Compounds)	Singapore
27 Oct - 1 November	AICHE Annual Meeting	San Diego, US

Dates are subject to change, please confirm details with event organizers.



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Hiden Isochema Limited  
422 Europa Boulevard, Warrington WA5 7TS  
Tel: +44 (0) 1925 244 678 Email: [info@hidenisochema.com](mailto:info@hidenisochema.com)

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